

Serial No.: 09/579,340
Group Art Unit: 2814

and a via provided therein; said via having a via entrant angle formed with said channel opening of greater than about 69 degrees..."

Based on the above, the Applicant's claimed invention requires a channel and a via because the Applicant's via entrant angle defined by a line connecting the rim of the channel and the rim of the via. This may be seen with reference to FIG. 2 and Specification page 7, lines 21-25, which states:

"In the present invention, the second channel opening 103 is configured so that its width at the rims 134 form the via entrant angle 69 with the rim 132 of the via opening 105. This causes the rims 134 to act as a collimator for subsequent plasma or ion deposition processes where the deposition of the second adhesion/barrier layer 138 requires this "channel collimator effect"."

Applicant respectfully traverses the rejections since the Applicant's claimed combination, as exemplified in claim 1, also includes the limitation not disclosed in APA or Wang of:

"...whereby said channel opening forms a collimator for said via..."

Based on the above, the Applicant's claimed invention requires the channel form a collimator for the via. A collimator is a device or structure for producing a particle beam, such as an ionized metal plasma, in which all the particle paths are substantially parallel.

The APA discloses an integrated circuit chip having a rectangular channel intersecting a cylindrical via (FIGs. 1A-C and specification pages 1-7). APA discloses on Specification page 3, lines 10-20, the problems with APA in that:

"The common problems associated with most of the seed layer deposition techniques are poor sidewall step coverage and conformality, i.e., the seed layer thickness is much higher in wide-open areas, such as on top of the channel oxide layer, in the upper portion of the sidewalls of the channels and vias, and bottom of the channels than in the lower portion of the sidewalls of the channels and vias. To guarantee a minimum seed layer thickness anywhere in the channel or vias, including at the lower portion of the sidewalls, the seed layer thickness in wide-open areas tends to be much higher. As the width of the channels and vias have decreased in size due to the size reduction in the semiconductor devices, an excessively thick seed layer in the wide-open areas interferes with the subsequent filling of the channel and vias with conductive materials leading to the formation of voids. These voids lead to connection and electro-migration failures."

Based on the above, APA has problems with guaranteeing seed layer thickness in view of the decreasing width of the channels and vias. There is no suggestion of any particular relationship between the channels and vias.

Serial No.: 09/579,340
Group Art Unit: 2814

Wang does not disclose a channel or seed layer and discloses a cylindrical via having a bevel or taper intersecting a planar surface; i.e., a cylindrical via having a conical opening such that the top of the via has a larger diameter than the bottom of the via. The angle of the bevel of the via relative to the top of the via is the Wang "angle of entrance". The Wang via is formed in a number of steps as follows as disclosed in Wang col. 3, lines 39-64, through:

"Refer now to FIG. 2 through FIG. 6, ...a method of forming a tapered contact via hole with a high aspect ratio. ...

...FIG. 2, a first via hole opening 32 is then formed in the insulating layer 30

...FIG. 3, the first via hole opening is extended to form a second via hole opening 34

...FIG. 4, the second via hole opening is extended to form a third via hole opening.

... FIG. 5, the third via hole opening is extended to form the contact via hole 38..

...FIG. 6, ...the formation of the contact via hole 38 is completed. In this case there is no re-entrance profile formed at the entrance to the contact via hole and the angle of entrance 54 into the contact via hole is substantially less than 90°...."

From the above, it is apparent that Wang first creates a hemispherical first via opening 32 under a masking layer 40, extends the hemispherical opening downward with a cylindrical opening 34, forms a more conical opening 36, and then finishes with a cylindrical opening through the bottom of the conical opening. This leaves a beveled cylindrical via.

Based on the above under *Graham v. John Deere Co.*, 383 Us 1, 148 USPQ 459 (Sup. Ct. 1966), the four factual inquiries would be resolved as follows:

The scope and contents of APA disclose a rectangular channel intersecting with a cylinder with no particular relationship and Wang discloses a beveled via.

The differences between the prior art and the claims at issue indicate that the Applicant's claimed limitation of a structure having a via entrant angle are not disclosed in APA. In Wang, without a channel, it cannot have a via entrant angle as claimed by Applicant. Taking APA and adding the Wang channel will result in a beveled cylinder via intersecting a rectangular channel. Since the beveled cylinder takes up more space than a non-beveled cylinder, this would be non-obvious because it would defeat the objective in APA of reducing the spacing between the channels and vias.

The differences between the prior art and the claims at issue indicate that the Applicant's claimed limitation of a collimeter does not exist in APA. In Wang, there is no

Serial No.: 09/579,340
Group Art Unit: 2814

disclosure of a structure to cause the particles of an ionized metal plasma to enter the via in parallel because the non-parallel plasma is blocked out by a separate structure such as the walls of the channel in Applicant's invention.

Resolving the ordinary skill in the art would indicate one having ordinary skill in semiconductor device manufacture. APA admits the unobviousness of the Applicant's invention on Specification page 3, lines 21-25, which states:

"A solution, which would form uniform seed layers in vias and result in an improvement in the subsequent filling of the vias by conductive materials, has long been sought, but has eluded those skilled in the art. As the semiconductor industry moves from aluminum to copper and other types of high conductivity materials, it is becoming more pressing that a solution be found."

Wang admits that it is concerned with forming a beveled hole by stating in Wang col. 1, lines 31-33:

"The importance of beveled contact holes has been recognized for some time and many have worked on methods of achieving them."

It is respectfully submitted that Applicant's invention does not disclose a beveled contact hole and the angle of entrance of Applicant's invention would be described as 90° as shown in FIG. 2.

In considering the objective evidence present in the application indicating obviousness or nonobviousness, it is respectfully submitted that this should be resolved in favor of nonobviousness because neither APA nor Wang discloses Applicant's claimed entrant angle or collimator structure.

It is submitted that the combination of APA and Wang would teach a channel having a beveled opening into a cylindrical opening would be taught away from since the conical openings would prevent the vias from being placed close together and therefore prevent decreased size in semiconductor devices.

Based on the above, and the factual inquiry set forth in *Graham vs John Deere Co.*, 383 US 1, 141 USPQ 459 (SUP. CT. 1966, that all four factors would mitigate towards the nonobviousness of Applicant's claims.

It is respectfully submitted that a prima facie case of obviousness under 35 USC §103 cannot be made for claims 1-20 because there is nothing to suggest the combination. As explained in *Laitram Corp. v. Cambridge Wire Cloth Co.*, 226 USPQ 298 at 293n (D. Md.

Serial No.: 09/579,340
Group Art Unit: 2814

Mag. 1985), aff'd in part, rev'd in part, and remanded, 785 F.2d 292, 228 USPQ 935 (Fed. Cir. 1986), cert. denied, 479 U.S. 820 (1986):

"The question is whether the prior art, considering its scope and content and the level of ordinary skill, must itself suggest the combination of separate elements into the claimed invention in suit, not just whether it illustrates separate elements..."

It is respectfully submitted that here, neither APA nor Wang discloses even the separate elements.

Conclusion

In view of the above, it is submitted that the claims are in condition for allowance and reconsideration of the rejections is respectfully requested. Allowance of claims 1-20 at an early date is solicited.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including any extension of time fees, to Deposit Account No. 01-0365 and please credit any excess fees to such deposit account.

Respectfully submitted,



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